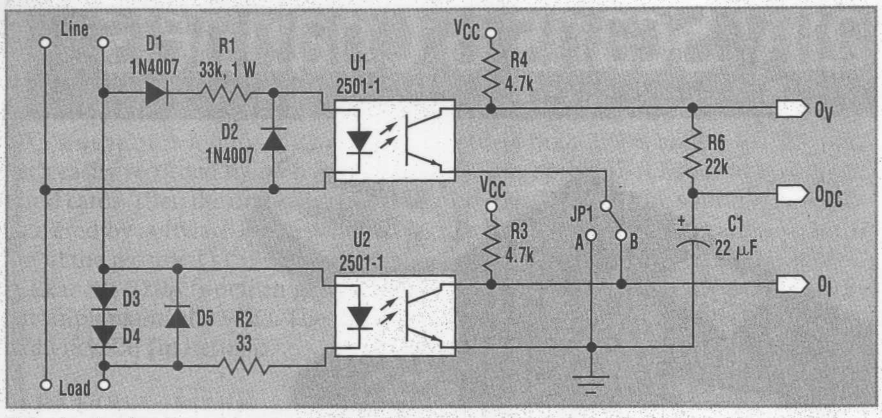
If jumper JP1 is in position "A," the network D1, D2, R1, and U1 supply a similar signal on output O_V, indicating the line voltage's zero crossing. O_V and O_I can be sent to a start-stop counter, or to a microcontroller to calculate the current-voltage phase shift.



This simple circuit senses an ac load's voltage and current phase. It also provides several ways to measure V-I phase displacement.

If precise phase measurements aren't required, and you don't need to know the phase sign (i.e., whether the load is capacitive or inductive), the circuit can be operated with JP1 in position "B." This way, output O_V supplies a "composite" signal whose duty cycle is proportional to the phase displacement. A 50% duty cycle means the load is purely resistive, while a 75% duty cycle indicates a purely reactive load. A continuous voltage means no load is present.

An analog output, O_{DC}, is also available for easier measurements. The output level is $0.5 \times V_{CC}$ in case of a resistive load, and $0.75 \times V_{CC}$ for a purely reactive load. If no load is present, then $O_{DC} = V_{CC}$.

High-Voltage Monitor Features High Accuracy

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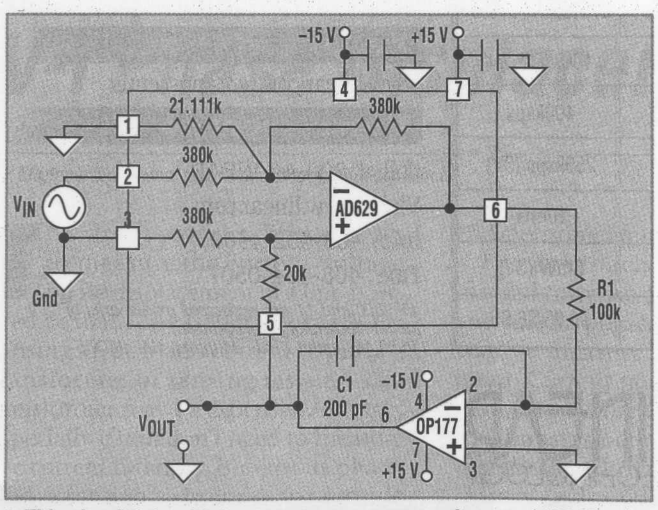
CIRCLE 522

Many applications call for measuring ac lines or high dc voltages. One common technique uses a large voltage divider followed by a buffer. Another employs an inverting attenuator. The problems associated with both methods stem from uneven power dissipation in the resistors, poor system accuracy due to resistor mismatch, and a large noise gain.

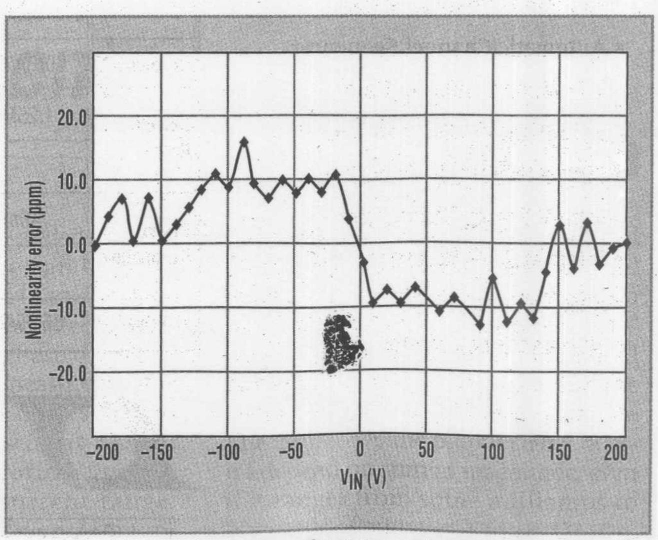
A third solution yields high-accuracy, high-voltage measurements *(Fig. 1)*. The integrator (OP177) supplies negative feedback around the difference amplifier (AD629), forcing its output to stay at 0 V. The voltage divider on the inverting input sets the common-mode voltage of the difference amplifier to $V_{IN}/20$. V_{OUT}, the integrator output and the measurement output, sources the required current to maintain the common-mode voltage. R1 and C1 compensate the system to a bandwidth of 300 kHz.

The transfer function is: $V_{OUT} = V_{IN}/19$. For example, a 400-V p-p input signal will produce a 21-V p-p output.

Figure 2 shows that the measured system nonlinearity is less than 20 ppm over the entire 400-V p-p input range. System noise is about 550 $nV/\sqrt{Hz}$ referred to the input, or around 2-mV peak noise voltage (10 ppm of full scale) over a 300-kHz bandwidth.



1. This circuit takes high-accuracy measurements over a 400-V p-p range. The transfer function is $V_{OUT} = V_{IN}/19$. R1 and C1 give the system a bandwidth of 300 kHz.



2. Over the full 400-V p-p range, the measured circuit nonlinearity is under 20 ppm.